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SOURCE Tehnika.ELECTRIFICATION OF YUGOSLAV RAILROADS

Engr Tomislav Ruzic

The first plan for the electrification of Yugoslav railroads was drawn in 1912 by the Krizik Brothers firm of Prague for the Sarajevo-Metkovic line. This was to be carried out with a single-phase current of 16 2/3 cycles and 11,000 volts. The electric power necessary was to come from the electric power plant in Jablanica, and be transmitted through 44,000-volt high-tension transmission lines, the voltage to be transformed by two transformer substations to 11,000 volts. The proposed electrification was not carried out because of the outbreak of World War I.

The Ministry of Transportation began the serious consideration of the question of the electrification of Yugoslav railroads in 1932. It had a skilled group study problems of electrical transportation and work on plans for the electrification of those lines where proper conditions existed.

The electrification of the narrow-gauge Uzice-Sarajevo Konjic line, about 240 kilometers long, was first studied. Electrification would eliminate the harmful effects of smoke in the 125 tunnels on the line and would also eliminate the need for clogged locomotives, facilitating the maintenance of lines and locomotives and reducing the need for keeping spare parts. The conclusion was that a direct current of 3,000 volts was most desirable. The possibility of using a single-phase 50-cycle current is still being studied. Electrification of this line with a single-phase current of 16 2/3 cycles was not considered because it was not suited for technical reasons to a narrow-gauge locomotive.

Electric power was to be obtained from a power plant to be built at Uvac, and from the thermal power plant at Breza, which would need to be enlarged. A three-phase current would be transformed into direct current in transformer substations by means of mercury correctors.

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Electrification of this line was not carried out because of difficulties in obtaining coal in Yugoslavia and abroad.

The electrification of the Susak-Skrljevo line, which is about 12 kilometers long, to eliminate poisonous and suffocating gases from steam engines, also was planned and then abandoned. Electrification of the whole line to Srpska Moravica, a total of 90 kilometers, was also planned, since large tunnels and steep gradients on this line make transportation with steam difficult. The plan for its electrification was based on the use of a direct current of 3,000 volts.

With the liberation, Istria and the Slovenian Primorje received the electrified Postojna-Sezana and Sv. Petar-Rijeka lines, about 115 kilometers long and with about 180 kilometers of track. Electrification of this line was done in 1938 by the Italian railroads. A direct current of 3,000 volts is used. The power comes from the electric power plants in Soca as a three-phase current of 10,000 volts and 42 cycles. Transformers at the power plants transform it to 50,000 and 130,000 volts.

Electric power is transmitted through double high-tension transmission lines for 150 kilometers from Soca to Rijeka, via Trieste and via Sv. Petar and Matulji for general use in Istria and the Primorje. The three-phase alternating current is transformed at the substations in Sv. Petar and Matulji into the single-phase direct current of 3,000 volts necessary for electrified railroad lines. In the near future, the power plants at Sv. Petar and Matulji will be connected with the power plants on the Drava River and in Trbovlje, Vinodol, and Zagreb.

Electrification of the line between Rijeka and Srpska Moravica is planned. Later, electrification will be extended as far as Zagreb. When the Postojna-Ljubljana line is electrified, this entire main line will operate by electricity.

The Rijeka-Postojna electric railroad line and the line to Trieste use 40,000 kilowatt-hours of power daily and about 15 million kilowatt-hours annually. The consumption of electric power per 1,000 gross ton-kilometers is about 50 kilowatt-hours when the annual traffic totals 250 million gross ton-kilometers. This consumption is 12 percent less than last year's, and is steadily decreasing as the result of better management and rational operation.

Electrification has increased transportation capacity 100 percent and cut costs 60 percent as compared with steam. Forty percent less personnel is required.

Further electrification of Yugoslav railroads requires: (1) power plants generating 10,000 to 100,000 kilowatts; (2) transformer stations rated at 10,000 to 220,000 volts; (3) high-tension transmission lines 100 to 2,000 kilometers long; (4) stationary or movable substations of an average rating of 2,000 to 6,000 kilowatts placed at intervals of 30 to 90 kilometers; (5) a network of copper trolley wires; (6) equipment for installing the trolley-wire network, poles averaging 25 to 60 meters apiece; (7) electric locomotives and electric-motor cars with an average output of 400 to 4,000 kilowatts and speed of 50 to 150 kilometers per hour, one for each 7 to 10 kilometers of electrified line; (8) protection of all equipment of electrified railroad lines; (9) workshops for repair of all equipment and rolling stock; (10) a developed electrical machine industry to provide reserve materials and build new installations and rolling stock, requiring 1,000 workers and 5,000 kilowatts of power for machine tools to electrify 100 kilometers of railroad line; (11) new qualified personnel for management and operation, with an average of two white-collar workers for each kilometer of electrified railroad line; (12) technical and mechanization personnel, with an average of 30 workers for each kilometer of electrified railroad to be built; (13) funds for procuring raw materials, allowing 10 million dinars for each kilometer of line with amortization in 10 to 15 years.

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Consumption of electric power on electrified railroads averages about 50 kilowatt-hours for each 1,000 gross ton-kilometers at a present average cost of 0.5 dinar per kilowatt-hour. Consumption of coal is about 0.120 ton at 800 dinars per ton.

Electrification of the lines from Rijeka to Zagreb and from Postojna to Ljubljana as extensions of the electrification already existing, then the electrification of the Ljubljana-Zagreb-Belgrade-Nis line, and the lines toward the sea (especially toward Sarajevo) will mean a broad expansion of all branches of the electric industry. The electrical economy is scheduled to provide 300 million kilowatt-hours of electric power annually for this electrification.

The following map shows existing and projected electrified railroad lines in Yugoslavia.

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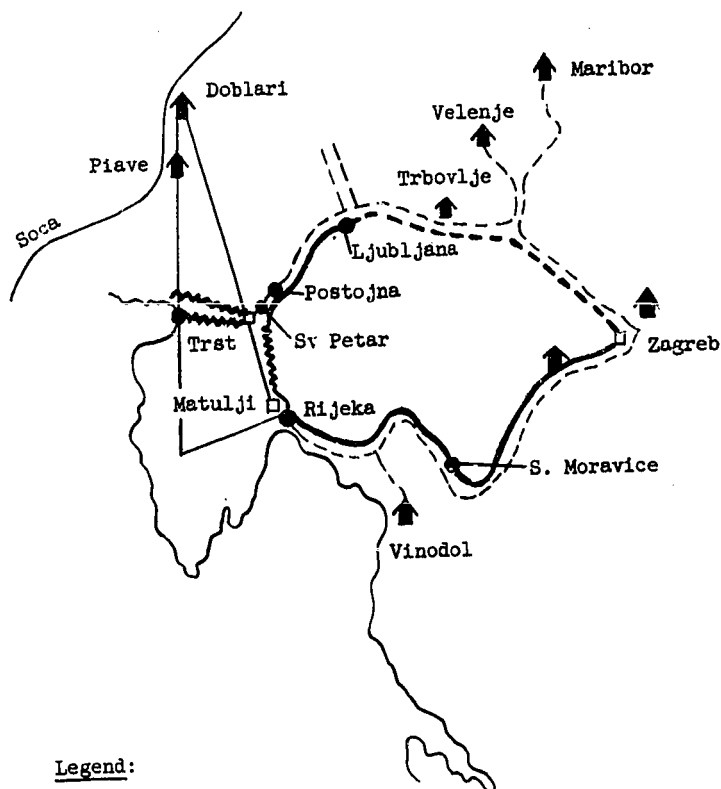
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Legend:

Power plant



Present high-tension transmission lines



Projected high-tension transmission lines



Electrified railroad line projected



Electrified railroad line in planning stage



Existing electrified railroad line



Electric substations

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